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(56) Documents Cited

GB 2287364 A

EP 0583681 A1

EP 0427563 A2

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US 5073124 A

US 4912401 A

US 4421368 A

(58) Field of Search

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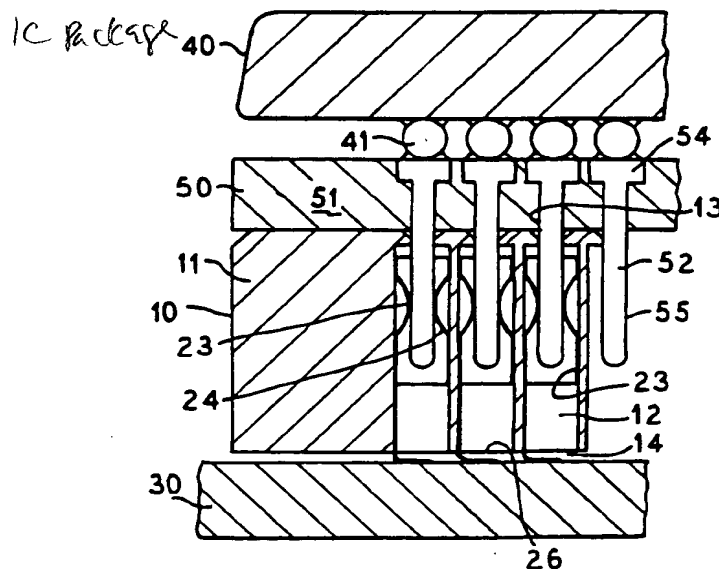
INT CL<sup>6</sup> H01R , H05K

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## (54) Miniature grid array socketing system

(57) A miniature grid array socketing system is provided having a socket 10 having a footprint corresponding to the footprint of an I.C. package 40 and/or of an adaptor 50. The contact pins 52 of the adaptor mate with socket contacts 23 mounted in passages of the socket. The adaptor has mounted thereto an I.C. package 40. For example, a ball grid array package having a 20 x 20 array on .050 x .050 inch spacing may be mounted on an adaptor which is mounted to a socket having corresponding .060 inch x .060 inch spacings. The socket contacts are inspectable from above the passages of the socket and without any real estate penalty from the surface mount socket. Interconnected socket contacts are made on a larger spacing than required, which is then reduced by corrugation.

FIG. 2



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FIG. 1

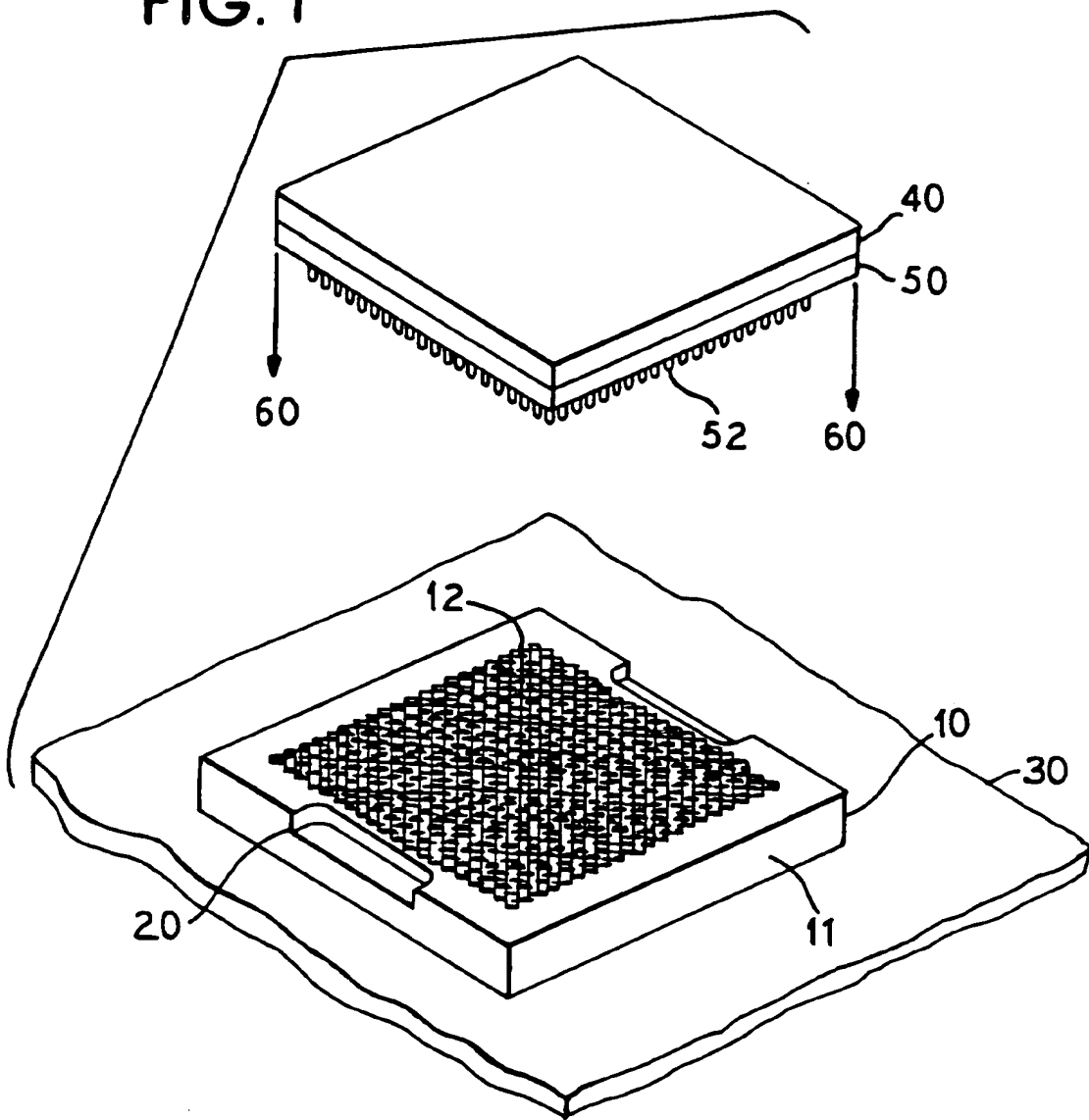
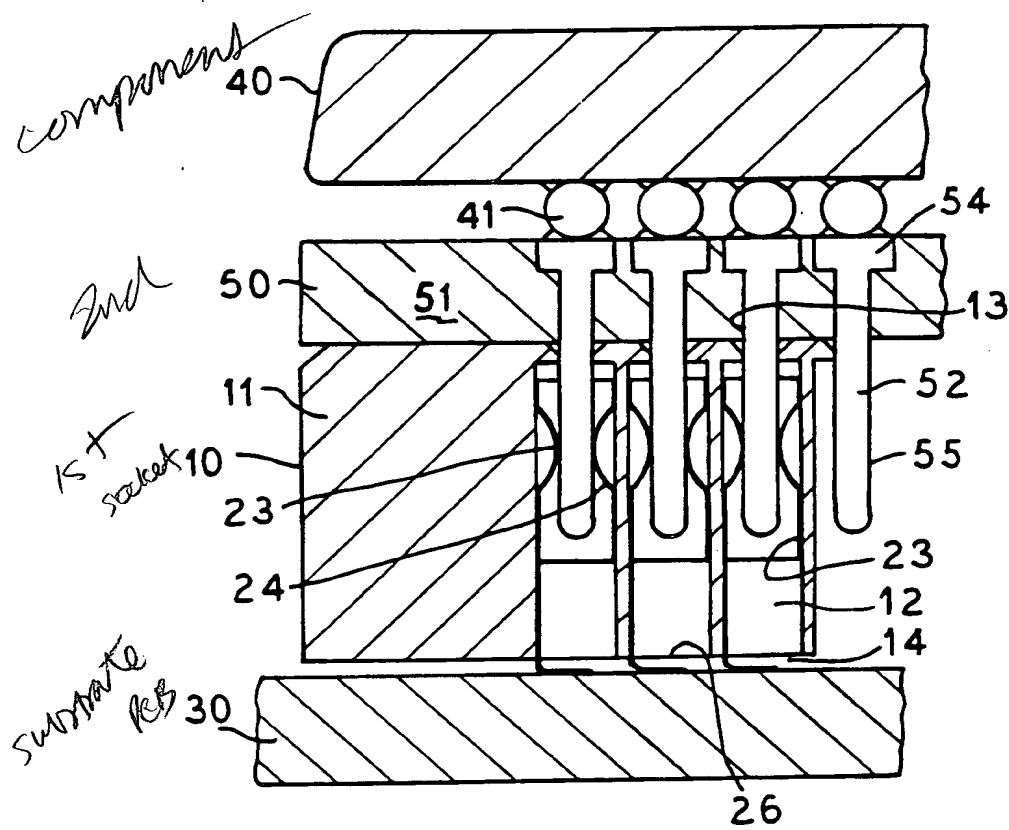


FIG. 2



**MINIATURE GRID ARRAY SOCKETING SYSTEM****Background of the Invention**

The present invention relates to an electrical connector and, in particular, to a miniature grid array socket and system.

Integrated circuits (I.C.'s) have become the world standard for electronic circuits. These range from basic transistor networks to complex memory, microprocessor and multi-chip module circuits. The common denominator to all such circuits is that they are produced en masse on a substrate such as silicon and then separated into individual units commonly known as chips. The majority of chips are then mounted in a carrier for subsequent incorporation into end products. The basic size, shape and construction of the carrier is commonly known as the package and many standard packages have emerged. Some examples are commonly known as D.I.P., S.O.J., P.L.C.C., Q.F.P., and B.G.A. Chip packages have developed to accommodate both circuit function, i.e. number and placement of leads and assembly trends, i.e. through-board and surface mount solder assembly. While the majority of I.C. devices are hard-soldered in place, several factors, such as device availability, testing, upgrades, etc., have traditionally shown that there is a need to socket I.C.'s regardless of their package. In fact, I.C. sockets are known in the art for receiving pin grid array packages (P.G.A.) on .100 inch x .100 inch

spacing. However, there are many miniature I.C. packages which have spacing less than .100 inch x .100 inch. It is the intent of this invention to provide a simple, economical, reliable, and space-efficient socketing system, targeted for today's high pin count, miniature surface mount I.C. packages, such as quad flat packs (Q.F.P.) and ball grid arrays (B.G.A.).

Summary of the Invention

It is an object of the present invention to provide a socket which may intermate with various miniature I.C. carrier packages.

It is another object of the present invention to provide a socket which may intermate with a ball grid array package.

It is a further object of the present invention to provide a miniaturized socket which may intermate with a quad flat pack.

It is another object of the present invention to provide a socket which may receive a pin adaptor upon which various I.C. packages may be mounted.

It is a further object of the present invention to provide a socket having a footprint identical to the I.C. package mounted thereto.

It is a further object of the present invention to provide a socket having a footprint identical to the adaptor mounted thereto.

It is also an object of the present invention to provide a surface mount socket.

It is another object of the present invention to provide a socket which has no real estate penalty on a printed circuit board.

5 It is a further object of the present invention to provide a socket having low insertion force.

According to the objects of the present invention, an electrical socket connector is provided for receiving an I.C. package mounted to an adaptor having an array of contact pins to be mated with the socket comprising a  
10 housing having an array of passages for receiving the contact pins. Miniature socket contacts are mounted within the passages and receive the contact pins of the adaptor. The array of passages are spaced in the housing on .060 inch centers or less. The socket contacts  
15 include a pair of opposed working beams for mating with the contact pins. The socket contacts include a J-lead tail adjacent to a bottom opening of the passages.

The socket includes notches on the top surface to allow for ejection of the adaptor. The socket adaptor  
20 I.C. package combination may include a heat sink. The J-leads of the contacts are oriented in an array corresponding to the orientation of the array of I.C. package leads. The adaptor may receive a ball grid array package. In a further embodiment, the adaptor may  
25 receive a quad pack.

A method of forming the socket includes the steps of forming the contacts in a corrugated die. The corrugated die allows for the reduction of the spacing of the contacts from .100 inch to .060 inch or less.

The contacts may press-fit within the socket. In a further embodiment, the contacts may captively be held in the housing to allow for contact float in the vertical direction. The contacts may comprise a box contact having opposed working beams spaced less than the diameter of the contact pin. In a further embodiment, the contact may be tulip-shaped. The pair of opposed working beams of the socket contacts may be plated with gold. The contacts may be formed of beryllium copper.

These and other features of the invention are set forth below in the following detailed description of the presently preferred embodiments.

#### Brief Description of the Drawings

There is shown in the drawings a presently preferred embodiment of the present invention wherein like numerals in the various figures pertain to like elements.

Figure 1 is an elevation view of the miniature grid array socketing system in a non-mated relation.

Figure 2 is a side elevation cut-away view of a miniature grid array socketing system in a mated position.

#### Detailed Description of the Preferred Embodiments

An embodiment of the miniature grid array socketing system of the present invention is best understood by Figs. 1-2.

Turning to Fig. 1, socket 10 is mounted to printed circuit board 30. I.C. package 40 is mounter to adaptor 50. In a preferred embodiment, the I.C. package is a

ball grid array 40. The ball grid array 40 and the adaptor 50 package combination is moved in the direction of arrows 60 and mated with the socket 10. The adaptor 50 includes contact pins 52 arranged in an array  
5 corresponding to the array of leads of the ball grid array package 40 mounted thereto. In the embodiment shown in Fig. 1, the ball grid array 40 includes contact pins 52 in a 20 x 20 array on .050 inch x .050 inch spacing. However, any variety of I.C. packages can be  
10 used with this invention including quad flat packs and/or ball grid array packages of various sizes including, but not limited to, 19 x 19 arrays on a .060 inch x .060 inch spacing, or any such arrangement thereof. The socket housing 11 in a preferred embodiment is 1.25 inch x 1.25  
15 inch x .187 inch and is formed of any suitable polymer material.

The socket housing 11 includes passages 12 in an array corresponding to the contact pins 52 of the adaptor 50 which correspond to the array of leads of the ball  
20 grid array 40.

Therefore, the embodiment of the socket housing 11 includes passages 12 in a 20 x 20 array having .050 inch x .050 inch spacing corresponding to the I.C. package mounted thereto. The socket 10 is mounted to the printed  
25 circuit board 30 prior to mating with the adaptor B.G.A. package combination. The socket 10 includes surface mount ~~contacts~~ (See Fig. 2) which allow for the surface mounting of the socket housing 11 to the printed circuit board 30. Any method of mounting is possible; however,

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in a preferred embodiment, the socket 19 is mounted to the printed circuit board 30 via infrared reflow soldering. Prior to the mating of the B.G.A. 40 adaptor 50 combination, the socket 10 may be inspected by viewing  
5 the surface mount contact tails by looking down into the passages 12. In a preferred embodiment, a boroscope may be used to inspect the contacts in the passages 12. It can thus be appreciated that a system wherein the footprint of the socket being nearly identical to the  
10 footprint of the I.C. package mounted thereto is provided by the present invention. Such a system provides no real estate penalty on the printed circuit board. In fact, in the instant where a quad flat pack is mounted according to the system of the present invention, a real estate  
15 savings may occur. In particular, an adaptor which receives a Q.F.P. having a large diameter including the horizontally extending contact tails may have contact pins on .060 inch x .060 inch spacing or less to mate to a socket having a corresponding footprint to the adaptor  
20 and smaller than the I.C. package. Also, due to the open design of the socket system of the present invention, the B.G.A. 40 may have a heat sink mounted to its top.

The socket 10 includes notches 20 which aid in the removal of the B.G.A. 40 adaptor 50 package combination  
25 after mating. The notch 20 may accept any type of ejection tool. As well, the socket 20 may include any number of ejection mechanisms such as lift bars or crank mechanisms.

Turning to Fig. 2, the socket 10 is shown having the adaptor 50 mounted thereto. The ball grid array 40 is mounted to the adaptor 50. The socket 10 is mounted to the printed circuit board 30. In a preferred embodiment, the adaptor 50 includes an adaptor housing 51 in which are mounted contact pins 52. The contact pins 52 include a head 54 and a mating portion 55. The balls 41 of the ball grid array 40 are soldered to the head 54 of the contact pins 52.

The socket housing 11 includes passages 12 for receiving contact pins 52. The passages 12 include a top opening 13 and a bottom opening 14. The top opening 13 of the passages 12 include a conical surface in order to aid in the insertion of the contact pins 52. The socket contacts 22 are mounted within the passages 12 of the socket housing 11. In a preferred embodiment, box contacts are used having a pair of opposed working beams 23,24. In an alternative embodiment, the contacts 22 may also have other shapes including a tulip-shape contact. The socket contacts 22 are made of beryllium, copper or phosphor bronze and the pair of opposed working beams 23,24 are gold plated. Such an arrangement allows for the low insertion force of the socket 10. In a preferred embodiment, an insertion force of eight pounds (8 lbs.) per one hundred contacts or less is achieved. The contact pins 52 are likewise gold plated at mating portions 55. In a preferred embodiment, the socket contacts 22 are press-fit within the socket passages 12. In order to aid in the assembly of the contacts to the

socket housing 11, a method of forming contacts has been devised which allows a single die to be used for various sized sockets. In particular, a method for manufacturing the socket contacts 22 includes molding the socket housing 11 having passages 12 therein. The socket contacts 22 are manufactured from a die having spacings greater than .060 inch. In a preferred embodiment, the spacings are .100 inch. A corrugation station is included to reduce the spacing to a desired length corresponding to the spacing of the socket 10. In a preferred embodiment, the spacing is reduced to .060 inch or less. The reduced spaced socket contact 22 may then be mounted to the socket 10.

However, the socket contacts 22 may also be mounted within the housing of the socket 10 via other means which allow the contacts to float in a vertical direction. The ability of the contacts 22 to float within the socket housing 11 will enable the socket to react to the coefficient of expansion which may occur on the printed circuit board 30. It is also possible to use barbs which protrude from the passage 22 in order to enhance the friction fit of the contact 22 within the passage 12. In a preferred embodiment, the contact pins 52 have a diameter of .017 inches to .018 inches. The spacing between the pairs of opposed working members 23,24 of the contacts 22 is less than the diameter of the contact pins 52. Therefore, upon insertion of the contact pins 52 within passages 22, a positive connection is made between the contact pins 52 and the socket contacts 22 and the

opposed pair of working beams 23,24 are compressed towards the walls of the passages 22.

The socket contacts 22 include J-lead tails 26. The J-lead tails 26 are oriented below the bottom opening 14 of the passages 12 of the socket contacts 22 for which the J-lead tail 26 is attached. This orientation of the J-lead tail 26 adjacent to the bottom opening 14 of the passage 12 allows for inspection of the contacts 22 from the top opening 13 of the passage 12. Therefore, before mating of the adaptor 50 to the socket 10, the passages are clear, and the J-lead tail 26 is inspectable for viewing in a vertical direction down through the top opening 13 of the passage 12. This arrangement allows for the inspection of the soldering of the socket contacts 12 to the printed circuit board 30. In a preferred embodiment, the J-lead tail 26 is mounted on a solder pad correspondingly located to the surface of the printed circuit board 30.

From the foregoing, it will be observed that numerous variations and modifications may be effected without departing from the spirit and scope of the novel concept of the invention. It is to be understood that no limitation with respect to the specific apparatus illustrated herein is intended or should be inferred. It is, of course, intended to cover by the appended claims all such modifications as fall within the scope of the claims.

**I CLAIM:**

1. A miniature grid array socketing system for receiving an I.C. package and corresponding adaptor having contact pins, the socket comprising:

5 a housing having an array of passages located correspondingly to the array of contact pins of said adaptor; and

socket contacts mounted within said passages having contact tails which provide for a footprint corresponding to the I.C. package footprint.

2. The socket of Claim 1 wherein said passages have a .060 inch x .060 inch spacing or less.

3. The socket of Claim 1 wherein said socket contact provides for a surface mount socket.

15 4. The socket of Claim 3 wherein said socket contacts include J-lead tails.

5. The socket of Claim 1 wherein said contacts include a pair of opposed working beams for receiving said contact pin of said adaptor.

20 6. The socket of Claim 5 wherein said pair of opposed working beams are spaced apart less than the diameter of said contact pins.

7. The socket of Claim 1 wherein said I.C. package is a ball grid array.

25 8. The socket of Claim 1 wherein said I.C. package is a quad flat pack.

9. The socket of Claim 1 wherein said socket is press-fit within said housing of said socket.

10. The socket of Claim 1 wherein said socket contact is floatingly mounted within said housing of said socket.

5 11. The socket of Claim 1 wherein said socket is tulip-shaped.

12. The socket of Claim 1 wherein said socket contact is box-shaped.

13. The socket of Claim 1 wherein said contact is formed of beryllium copper or phosphor bronze.

10 14. The socket of Claim 1 wherein an insertion force of eight pounds (8 lbs.) per one hundred contacts or less is required to insert said adaptor into said socket.

15 15. The socket of Claim 1 wherein said leads of said socket contacts are inspectable from above said socket.

16. A miniature grid array socketing system wherein an I.C. package is mounted to an adaptor having contact pins received by a socket comprising:

20 a housing having an array of passages located correspondingly to the array of said adaptor contact pins having .060 inch x .060 inch spacing or less; and

25 surface mount socket contacts mounted within said passages providing a footprint corresponding to the footprint of said I.C. package.

17. A miniature grid array socketing system wherein an I.C. package is mounted to an adaptor having contact pins received by a socket comprising:

a housing having an array of passages therein located correspondingly to the array of said adaptor contact pins having .060 inch x .060 inch spacing or less; and

5 surface mount socket contacts mounted within said passages providing a footprint corresponding to the footprint of said adaptor.

18. A method of forming a miniature grid array socketing system comprising the steps of:

10 mounting a socket having contacts forming a footprint to a circuit board;

mounting an I.C. package having said corresponding footprint to an adaptor having contact pins; and

mounting said adaptor to said socket.

15 19. The method of Claim 18 wherein said footprint includes .060 x .060 inch spacing or less.

20. The method of Claim 18 further comprising the steps of:

molding said socket having passages therein; and

20 forming socket contacts from a die having spacings greater than .060 inch and including a corrugation station to reduce said spacings to .060 inch spacings or less wherein said socket contact has reduced spacing to aid in assembly thereof.

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1. A miniature grid array socketing system including an I.C. package mounted to an adaptor having contact pins, the socket comprising:
  - 5 a housing having an array of passages located correspondingly to the array of contact pins of said adaptor; and
  - socket contacts, mounted within said passages, having J-lead surface mount contact tails which provide for a footprint corresponding to the I.C. package footprint and a pair of opposed working beams for receiving said
  - 10 contact pin of said adaptor.
2. The socket of Claim 1 wherein said passages have a .060 inch x .060 inch spacing or less.
- 15 3. The socket of claim 1 wherein said socket contact provides for a surface mount socket.
4. The socket of Claim 1 wherein said pair of opposed working beams are spaced apart less than the diameter of said contact pins.
- 20 5. The socket of claim 1 wherein said I.C. package is a ball grid array.
6. The socket of Claim 1 wherein said I.C. package is a quad flat
- 25 pack.
7. The socket of Claim 1 wherein said socket is press-fit within said housing of said socket.
- 30 8. The socket of claim 1 wherein said socket contact is floatingly





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mounted within said housing of said socket.

9. The socket of Claim 1 wherein said socket is tulip-shaped.
- 5 10. The socket of Claim 1 wherein said socket contact is box-shaped.
11. The socket of Claim 1 wherein said contact is formed of beryllium copper or phosphor bronze.
- 10 12. The socket of Claim 1 wherein an insertion force of eight pounds (8 lbs) per one hundred contacts or less is required to insert said adaptor into said socket.
13. The socket of Claim 1 wherein said leads of said socket contacts  
15 are inspectable from above said socket.
14. A miniature grid array socketing system wherein an I.C. package is mounted to an adaptor having contact pins received by a socket comprising:  
20 a housing having an array of passages located correspondingly to the array of said adaptor contact pins having .060 inch x .060 inch spacing or less; and  
surface mount socket contacts, mounted within said passages, having J-lead surface mount contact tails providing a footprint corresponding to  
25 the footprint of said I.C. package and a pair of opposed working beams for receiving said contact pin of said adaptor.
15. A miniature grid array socketing system wherein an I.C. package is mounted to an adaptor having contact pins received by a socket  
30 comprising:



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a housing having an array of passages therein located correspondingly to the array of said adaptor contact pins having .060 inch x .060 inch spacing or less; and

5 surface mount socket contacts, mounted within said passages, having J-lead surface mount contact tails providing a footprint corresponding to the footprint of said adaptor, and a pair of opposed working beams for receiving said contact pin of said adaptor.

16. A method of forming a miniature grid array socketing system  
10 comprising the steps of:

mounting a socket having contacts forming a footprint to a circuit board;

mounting an I.C. package having said corresponding footprint to an adaptor having contact pins; and

15 mounting said adaptor to said socket.

17. The method of Claim 16 wherein said footprint includes .060 x .060 inch spacing or less.

20 18. The method of Claim 16 further comprising the steps of:

molding said socket having passages therein; and

forming socket contacts from a die having spacings greater than .060 inch and including a corrugation station to reduce said spacings to .060 inch spacings or less wherein said socket contact has reduced spacing  
25 to aid in assembly thereof.

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**Patents Act 1977**  
**Examiner's report to the Comptroller under Section 17**  
**(The Search report)**

Application number  
GB 9519588.9

**Relevant Technical Fields**

- (i) UK CI (Ed.N)      ECSJ ECBD EEKD ECBF  
(ii) Int CI (Ed.6)      H01R; H05K

Search Examiner  
MRS J BANNISTER

Date of completion of Search  
14 DECEMBER 1995

**Databases (see below)**

(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

Documents considered relevant following a search in respect of Claims :-  
1, 16, 17, 18 AT LEAST

(ii) ONLINE: WPI

**Categories of documents**

- |                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                           |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>X:</b> Document indicating lack of novelty or of inventive step.</p> <p><b>Y:</b> Document indicating lack of inventive step if combined with one or more other documents of the same category.</p> <p><b>A:</b> Document indicating technological background and/or state of the art.</p> | <p><b>P:</b> Document published on or after the declared priority date but before the filing date of the present application.</p> <p><b>E:</b> Patent document published on or after, but with priority date earlier than, the filing date of the present application.</p> <p><b>&amp;:</b> Member of the same patent family; corresponding document.</p> |
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Category	Identity of document and relevant passages		Relevant to claim(s)
X, P	GB 2287364 A	(IBM) see Figure 2, housing/socket 41, adaptor 30, ic/ga 10	1-3, 5, 6, 8, 11, 12, 15-19 at least
X	EP 0583681 A1	(HEWLETT-PACKARD) eg Figure 1 housing/socket 13/12, adaptor 11, ic 10 column 4 lines 1-7	1-3, 9, 10, 15-19 at least
X	EP 0427563 A2	(ADVANCED INTER) Figures 4, 12, housing/socket 16, adaptor 28, ic 10	1, 2, 5, 6, 9, 15-19 at least
X	WO 91/15881 A1	(DITTO) see the figures	1-3, 5, 6, 8, 9, 15, 17-19
X	US 5073124	(AMP) see Figure 10, housing/socket 130, adaptor 127, ic 112	1, 2, 15-19
X	US 4912401	(TEKTRONIX) see Figure 2 housing/socket 26, adaptor 16/14, ic 24	1, 2, 15-19

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Continuation page

Category	Identity of document and relevant passages	Relevant to claim(s)
X	US 4421368 (WEC) see Figure 4, housing/ socket 43, adaptor 25, ic 30	1, 2, 5, 6, 9, 13, 15-19